

Remarks

Thorough examination by the Examiner is noted and appreciated.

The claims have been amended and new claims added to clarify Applicants invention. No new matter has been added.

For example support for the amendments is found in the previously presented claims as well as the Specification at:

paragraph 0011

"Still another object of the present invention is to provide a new and improved substrate cleaning method which prevents or substantially reduces galvanic corrosion of metal lines on semiconductor wafer substrates."

paragraphs 0030 and 0031:

"After the substrate 32 is placed on the substrate support 30 and the cleaning fluid 14 is provided in the cleaning fluid holding tank 12, **the cleaning chamber 28 is set at the temperature and pressure conditions that are required to transform the cleaning fluid 14 from the liquid or gaseous state to the supercritical fluid state**, and these threshold temperature and pressure conditions vary according to the cleaning fluid used, as shown in Table I. By operation of the pump 18, **the cleaning fluid 14 is then pumped from the cleaning fluid holding tank 12, through the holding tank outlet conduit 16 and into the mixing conduit 20. Simultaneously, by operation of the pump 24, the solvent 23 is distributed from the solvent holding tank 22 and into the mixing conduit 20. As they are pumped through the**

mixing conduit 20, the cleaning fluid 14 and the solvent 23 mix together to define a cleaning fluid/solvent mixture 26 that enters the cleaning chamber 28.

As the cleaning fluid/solvent mixture 26 enters the cleaning chamber 28, the cleaning fluid therein reaches the supercritical temperature and pressure which transform it from the liquid or gaseous state to the supercritical state, at which point the cleaning fluid forms a supercritical cleaning fluid 34. The supercritical cleaning fluid 34, which is typically non-conductive, contacts the substrate 32 and removes particles and other residues remaining from the CMP or other process therefrom. Typically, the supercritical cleaning fluid 34 remains in the cleaning chamber 28 for a period of typically about 5.about.10 minutes, at which point substantially all of the particles and other residues have been removed from the substrate 32 by the supercritical cleaning fluid 34."

And at paragraph 0026:

"The cleaning fluid is typically mixed with a solvent prior to forming the supercritical cleaning fluid from the liquid or gas cleaning fluid. Examples of suitable solvents in this regard include isopropyl alcohol or other alcohols, ethylene glycol, hydrogen fluoride or ammonium hydroxide, in non-exclusive particular."

And at paragraph 0034:

"Referring next to FIG. 3A, a substrate 300 is provided. The substrate may be a semi-conducting substrate with a dielectric layer 302 deposited on top. The dielectric layer 302 can be SiO<sub>2</sub> deposited using a TEOS process. Subsequently, photolithography and etching steps are used to define the dielectric layer forming a trench 304. A conductive metal layer 306 is then deposited in the trench and on top of the dielectric layer. The conductive metal layer may be Cu or W. The conductive layer is planarized to form multiple metal conductive lines. CMP slurry solution or particles may be left on the substrate during the CMP planarization process."

Claim Rejections under 35 USC 102

1. Claims 1-2, 5-8, 13-15, and 17-19 stand rejected under 35 USC 102(e) as being anticipated by Humayun et al. (US 6,905,556).

Humayun et al. disclose a supercritical fluid cleaning process and a method for delivering a reagent to a wafer (see Abstract). Humayun et al. disclose a process where a solvent, surfactant and reagent are combined and formed into a supercritical fluid prior to delivery to a process chamber (see Abstract; col 5, lines 4-24). Humayan disclose in preferred embodiments that the primary solvent is first made supercritical followed by addition of a surfactant and then a reagent to form the supercritical fluid (see Figure 3). Humayan teaches that the surfactant increases the solubility of a reagent in the primary solvent e.g., a condensable gas including a wide variety of gases (see col 4, lines 31-49). Thus, the importance of adding the reagent (col 5, lines 25-31) following addition of the surfactant to the supercritical primary solvent prior to delivery to a process chamber (col 5, line 56 to col 6, line 12). For example, Humayan teaches that the reagent is insoluble or sparingly soluble in the solvent, even at supercriticality. Humayan also teaches that less preferably, the **reagent and surfactant may be**

**premixed** and pumped together **into the supercritical solvent** or that the surfactant may be added to the solvent before the solvent is made supercritical (col 10, lines 58-67) or that the reagent may be added directly into the supercritical mixture delivered to the process vessel (col 11, lines 22-27).

Thus Humayun et al. fail to disclose several elements of Applicants invention, including those elements in **bold type**:

"A method of cleaning substrates, comprising the steps of:

providing a cleaning fluid;

**mixing a solvent with said cleaning fluid to form a cleaning fluid mixture;**

**delivering said cleaning fluid mixture to a cleaning chamber;**

**forming a supercritical cleaning fluid from said cleaning fluid mixture in said cleaning chamber; and**

contacting the substrate with said supercritical

cleaning fluid in said cleaning chamber."

Thus, Humayun et al. is clearly insufficient to anticipate Applicants invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

2. Claims 1-4, 11-13, 15-17, and 19-20 stand rejected under 35 USC 102(e) as being anticipated by Xu et al. (US 2003/0125225).

Xu et al. disclose supercritical fluid processes where the supercritical fluid species is selected from the group consisting of **carbon dioxide, oxygen, argon, water, ammonia and mixtures thereof** (see Abstract; paragraph 010). Xu et al. disclose that

the supercritical formulation includes a supercritical fluid species, at least one co-solvent (e.g. alcohols/ammonium fluoride-see paragraphs 0017, 0029, and 0030), and at least one additional active agent and may include surfactants and/or chelating agents (paragraph 0038, 0040, 0043-0049). Xu et al. disclose that a cleaning process including a supercritical fluid species, at least one co-solvent, and at least one additional active agent may be used for removing CMP residues (paragraph 0054).

In a specific cleaning process, Xu et al. disclose that the cleaning formulation may comprise CO<sub>2</sub>, alone, or more preferably a mixture of CO<sub>2</sub>, co-solvent, and at least one additional active agent (paragraph 0057).

Xu et al. disclose that a process vessel is **first purged with the non-supercritical supercritical process gas** e.g., CO<sub>2</sub>. After purging, the process vessel is heated to a supercritical temperature and then pressurized to a supercritical pressure. **Once supercritical pressures and temperatures are reached, the process vessel is charged with supercritical CO<sub>2</sub>.** (paragraph 0056-0058).

Thus Xu et al. fail to disclose several elements of Applicants invention, including those elements in **bold type**:

"A method of cleaning substrates, comprising the steps of:

providing a cleaning fluid;

**mixing a solvent with said cleaning fluid to form a cleaning fluid mixture;**

**delivering said cleaning fluid mixture to a cleaning chamber;**

**forming a supercritical cleaning fluid from said cleaning fluid mixture in said cleaning chamber; and**

contacting the substrate with said supercritical cleaning fluid in said cleaning chamber."

Thus, Xu et al. is clearly insufficient to anticipate Applicants invention.

"A claim is anticipated only if each and every element as

set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

3. Claims 1-2, 5-8, 13-15, and 17-19 stand rejected under 35 USC 102(e) as being anticipated by Vaartstra et al. (US 6,242,165).

Vaartstra et al. disclose a method for removing organic

material from a substrate using a composition including an oxidizer in a supercritical state selected from the group consisting of SO<sub>3</sub>, SO<sub>2</sub>, N<sub>2</sub>O, NO, NO<sub>2</sub>, O<sub>3</sub>, H<sub>2</sub>O<sub>2</sub>, F<sub>2</sub>, Cl<sub>2</sub>, Br<sub>2</sub>, and O<sub>2</sub>-see col 3, lines 12-17) in a supercritical state (see Abstract; col 2, lines 56-64; col 4, lines 14-19; col 5, lines 19-36). In another embodiment, Vaartstra et al. disclose a composition including a component in a supercritical state selected from the group consisting of CO<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>O, N<sub>2</sub>O, CO, N<sub>2</sub>, He, Ne, Ar, Kr, and Xe (col 3, lines 28-34; col 5, lines 49-60). Vaartstra et al. also disclose that inorganic acids may be present which may be or may not be in a supercritical state (col 6, lines 11-24).

The composition in a supercritical state is introduced into a pressureizeable chamber where the pressure and temperature are controlled **for maintaining at least one component of the composition in a supercritical state** (col 3, lines 49-63). Vaartstra et al. disclose that a supercritical fluid component e.g., CO<sub>2</sub> in the supercritical state may be added to a supercritical oxidizer; or a component not in a supercritical state may be added to a supercritical component either before or after it is brought into the supercritical state; or a component not in a supercritical state may be provided into an etching

chamber while the substrate is being exposed to the supercritical oxidizer component (col 6, lines 23-38). Vaartstra et al. also disclose that CO<sub>2</sub> may be in a supercritical state while the oxidizer is not in a supercritical state (col 7, lines 64-66).

Vaartstra et al. also disclose that a mixing manifold (122; Figure 2) is used to mix components prior to their entry into the pressure vessel (col 9, lines 8-11) **where the components are heated in the mixing manifold such that at least one component is in a supercritical state in the mixing manifold (col 9, lines 19-26) prior to entering the pressure vessel.**

Vaartstra et al. **alternatively** disclose that the components **may be separately plumbed (unmixed) into the pressure vessel where the components are then mixed and are then brought into the supercritical state (col 9, lines 31-35).**

Vaartstra et al. also disclose that the substrate may be one or more layers of semiconductor material and have a patterned resist layer (col 4, lines 30-57).

Thus Vaartstra et al. fail to disclose several elements of Applicants invention, including those elements in **bold type**:

"A method of cleaning substrates, comprising the steps of:

providing a cleaning fluid;

**mixing a solvent with said cleaning fluid to form a  
cleaning fluid mixture;**

**delivering said cleaning fluid mixture to a cleaning  
chamber;**

**forming a supercritical cleaning fluid from said  
cleaning fluid mixture in said cleaning chamber; and**

contacting the substrate with said supercritical  
cleaning fluid in said cleaning chamber."

Thus, Vaartstra et al. is clearly insufficient to anticipate  
Applicants invention.

"A claim is anticipated only if each and every element as  
set forth in the claim is found, either expressly or inherently  
described, in a single prior art reference." *Verdegaal Bros. v.*

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*Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

#### Claim Rejections under 35 USC 103

4. Claims 5-6, 10, 14 and 18 stand rejected under 35 USC 103(a) as being unpatentable over Xu et al., above.

Applicants reiterate the comments made above with respect to Xu et al.

Examiner acknowledges that Xu et al. fail to disclose that the **solvent is mixed with the cleaning fluid prior to forming supercritical fluid.**

Examiner argues that it would have been obvious to mix the solvent with the cleaning fluid prior to forming supercritical fluid "because it has been held obvious to change the sequence of mixing the ingredients, citing In re Burhans, 69 USPQ 330 (CCPA 1946) and In re Gibson, 5 USPQ 230 (CCPA 1930). Examiner argues that one of ordinary skill would expect that combining the solvent (with the cleaning fluid) prior to forming the supercritical fluid would give the same results since the mixture is applied in the critical state.

Applicants, however, respectfully note that the teachings of Humayan et al. refute the above argument by making clear that it is **preferable to add the surfactant to the solvent (cleaning fluid) in the supercritical state prior to adding a reagent** since the surfactant increase the solubility of the reagent in the supercritical fluid, thus making it clear that the order of

adding ingredients and whether or not the mixture is supercritical has critical operational effects. The teachings of Vaartstra et al. make clear that not all the components in a cleaning mixture are in a supercritical state. Xu et al., like Humayan et al. and Vaartstra et al. disclose introducing a supercritical fluid species (cleaning fluid) into the process vessel in a supercritical state.

Thus, even assuming *arguendo* that Examiner is correct in assuming Xu et al. could be modified without changing the principal of operation of Xu et al. and making it unsuitable for its intended purpose (introducing supercritical cleaning fluid into a preheated, pre-pressurized and purged process vessel), such modification does not produce Applicants disclosed and claimed invention.

"Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Conclusion

The cited references, individually or in combination, fail to produce Applicants invention, or recognize or provide a solution to the problem that Applicants have recognized and solved by their claimed invention and are therefore insufficient to make out a *prima facie* case of anticipation or obviousness with respect to Applicants disclosed and claimed invention.

The claims have been amended and new claims added to further clarify Applicants' disclosed and claimed invention. A favorable consideration of Applicants' claims is respectfully requested.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in condition for allowance for any reason, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that

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necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

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